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Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)			
Russell	Keene	Sudbury, MA			
<input type="checkbox"/> Additional inventors are being named on the _____ separately numbered sheets attached hereto					
TITLE OF THE INVENTION (280 characters max) FLOW THROUGH ISOLATION VALVE FOR HIGH PRESSURE FLUIDS					
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Respectfully submitted,

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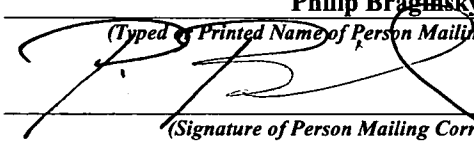
16787/WAA-358

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Invention: FLOW THROUGH ISOLATION VALVE FOR HIGH PRESSURE FLUIDS				
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FLOW THROUGH ISOLATION VALVE FOR HIGH PRESSURE FLUIDS

BACKGROUND OF THE INVENTION

Field of Invention

[0001] The invention relates generally to the field of high pressure fluids and, more specifically, to an isolation valve that permits introduction of an alternate flow path without interruption of flow from the fluid source.

Description of Related Art

[0002] Conventional 6-port face shear valves, also referred to as face seal valves, used in high pressure liquid chromatography (HPLC) provide ports that interface with the sample, the syringe, the pump, the column and the two ends of the sample loop. Such face seal valves must be rotated to switch from one port to another. The rotation of the face seal under high pressure inherently causes damage to the plastic mating surfaces because the fluid port openings must slide against the rotor surface causing fatigue of the rotor material. This results in shortened face seal valve life.

[0003] What is needed is an intermediary isolation valve that protects the face seal valve so that it will not be required to switch or rotate under high pressure. The isolation valve should not cause stoppage of flow during switching, and therefore should provide a substantially uniform, non-disrupted fluid introduction flow path.

BRIEF SUMMARY OF THE INVENTION

[0004] To address the above and other issues, the present invention describes a flow-through high pressure isolation valve for high pressure fluids, and which is particularly suitable for use in HPLC applications.

[0005] It is an object of this invention to minimize the face damage inherent in face-shear valves at high pressure because the fluid port openings do not slide against

[0006] The rotor surface causing fatigue of the rotor material. Therefore valve life when switching high pressure fluids is greater.

[0007] At higher chromatography pressures (>15,000 psig or 100 MPa), the flow-through isolation valve can be used to protect a conventional “flow-through isolation” inject valve so that it does not have to switch (turn) at high pressure.

[0008] In a particular aspect of the invention, the present invention is directed to a flow through isolation valve, the flow through isolation valve comprising: a stationary member; a movable member, a surface of the stationary member interfacing with a surface of the movable member; and at least one pin isolation valve. The at least one pin isolation valve has a flow through internal conduit, and is movably disposed so that the internal conduit is capable of fluidically communicating with at least one blank opening in the movable member, and is movably disposed so that the internal conduit within the pin isolation valve is capable of fluidically communicating with a flow through conduit in the movable member. The movable member moves by rotation around an axis of rotation or by at least one of linear and curvilinear translation. At least one pin isolation valve can be fluidically coupled to a sample loop of a face seal valve of a high pressure liquid chromatography (HPLC) system or fluidically coupled to a pump supplying high pressure liquid to a face seal valve of a HPLC system or fluidically coupled to a column discharging high pressure liquid from a face seal valve of a HPLC system.

[0009] In a specific aspect of the invention, the present invention is directed to a flow through isolation valve, the isolation valve disposed around an axis of rotation, and comprises: at least two opposing valve ends disposed around the axis of rotation; a rotor disposed between the valve ends, with an axis of rotation of the rotor being substantially one of parallel and coincident with the axis of rotation of the isolation valve, and the rotor is disposed such that orientation of the rotor can change by rotation around the axis of rotation of the rotor. The rotor has an outer surface having at least first and second

openings on the outer surface, at least two surfaces each intersecting the outer surface. A first flow-through conduit has an opening on a first of the at least two surfaces intersecting the outer surface and an opening on a second of the at least two surfaces intersecting the outer surface; and an opening on the outer surface coincident with the first opening on the outer surface and an opening on the first of the at least two surfaces intersecting the outer surface. A second flow through conduit has an opening on the outer surface coincident with the second opening on the outer surface and an opening on the second of the at least two surfaces intersecting the outer surface. There is at least one blank opening on the first of the at least two surfaces intersecting the outer surface, at least one blank opening on the second of the at least two surfaces intersecting the outer surface, with a first sealing annulus for sealing the openings on the first of the at least two surfaces intersecting the outer surface, and a second sealing annulus for sealing the openings on the second of the at least two surfaces intersecting the outer surface. The flow through isolation valve also has a first pin isolation valve having an internal conduit, with the first pin isolation valve disposed to move along the axis of rotation of the isolation valve through one of the valve ends; and movably disposed so that the internal conduit is capable of fluidically communicating with the at least one blank opening on the first of the at least two surfaces intersecting the outer surface, and movably disposed so that the internal conduit is capable of fluidically communicating with the flow through conduit having an opening on the outer surface and an opening on a second of the at least two surfaces intersecting the outer surface. The flow through isolation valve also includes a second pin isolation valve, with the second pin isolation valve disposed to move along the axis of rotation of the isolation valve through another one of the valve ends, the pin isolation valve including an internal conduit; and movably disposed so that the internal conduit is capable of fluidically communicating with the at least one blank opening on the second of the at least two surfaces intersecting the outer surface, and movably disposed so that the internal conduit within the second pin isolation valve is capable of fluidically communicating with the flow through conduit having an opening

on the outer surface and an opening on the second of the at least two surfaces intersecting the outer surface.

[0010] The axis of rotation of the rotor can be the centerline of the rotor and the axis of rotation of the isolation valve can be the centerline of the isolation valve. The rotor can further comprise: a rotor clamp having an outer surface and an inner surface, with the inner surface surrounding at least a portion of the outer surface of the rotor, a first opening on the outer surface of the rotor clamp penetrating the rotor clamp to coincide with the first opening on the outer surface of the rotor, and a second opening on the outer surface of the rotor clamp penetrating the rotor clamp to coincide with the second opening on the outer surface of the rotor. The flow through isolation valve can further comprise at least one of a (a) third pin isolation valve, and (b) fourth pin isolation valve. The third pin isolation valve has an internal conduit, and is disposed within the first opening on the outer surface of the rotor clamp so that the internal conduit of the third pin isolation valve is disposed to be in fluidic communication with the opening on the outer surface of the flow through conduit having an opening on the outer surface and an opening on the first of the at least two surfaces intersecting the outer surface of the rotor. The fourth pin isolation valve has an internal conduit, and is disposed within the second opening on the outer surface of the rotor clamp so that the internal conduit of the fourth pin isolation valve is disposed to be in fluidic communication with the opening on the outer surface of the flow through conduit having an opening on the outer surface and an opening on the second of the at least two surfaces intersecting the outer surface of the rotor.

[0011] The rotor clamp can further comprise drive means for driving the rotor to rotate around the axis of rotation of the rotor. The drive means can comprise a gear drive operator or a handle operator. At least one of the valve ends comprises typically: a stator enclosing the at least one pin isolation valve, with the stator adjacent to the rotor; a sealing layer enclosed within the stator and enclosing the at least one pin isolation valve

for sealing the at least one pin isolation valve; a Belleville spring washer; a Belleville spring; a load washer; and a spherical nut, the Belleville spring washer, the Belleville spring, the load washer and the spherical nut axially arranged to impose an axial force for sealing the sealing layer enclosing the pin isolation valve.

[0012] In an alternate embodiment, the flow through isolation valve comprises a stationary member; and a movable member. The stationary member and the movable member interface at a surface, with the movable member disposed to slide along the surface; and a chamber is disposed between the stationary member and the movable member. The chamber is bounded by the surface; and the movable member has a first flow through conduit having an opening interfacing with the chamber and an opening on a surface of the movable member not interfacing with the chamber; and a second flow through conduit having an opening interfacing with the chamber and an opening on a surface of the movable member not interfacing with the chamber, with a first blank opening on the surface bounding the chamber, and a second blank opening on the surface bounding the chamber. The flow through isolation valve can further comprise: a first pin isolation valve having an internal conduit, with the first pin isolation valve disposed within the opening of the first flow through conduit on a surface of the movable member not interfacing with the chamber, with the internal conduit of the first pin isolation valve for fluidically communicating with the first flow through conduit; and a second pin isolation valve having an internal conduit, with the second pin isolation valve disposed within the opening of the second flow through conduit on a surface of the movable member not interfacing with the chamber, with the internal conduit of the second pin isolation valve for fluidically communicating with the second flow through conduit. The flow through isolation valve can further comprise at least one of a (a) third pin isolation valve, and (b) fourth pin isolation valve. The third pin isolation valve has an internal conduit, and is disposed within an opening within the stationary member interfacing with the chamber so that the internal conduit of the third pin isolation valve is movably disposed to be in fluidic communication with the opening interfacing with the

chamber and an opening on a surface of the stationary member not interfacing with the chamber, and the internal conduit is movably disposed to be in fluidic communication with the first blank opening on the surface bounding the chamber. The fourth pin isolation valve has an internal conduit, and is disposed within an opening within the stationary member interfacing with the chamber so that the internal conduit of the fourth pin isolation valve is movably disposed to be in fluidic communication with the opening interfacing with the chamber and an opening on a surface of the stationary member not interfacing with the chamber, the internal conduit of the fourth pin isolation valve movably disposed to be in fluidic communication with the second blank opening on the surface bounding the chamber. The flow through isolation valve can further comprise a housing enclosing the stationary member and the movable member or a housing enclosing the stationary member and the movable member and at least one of the pin isolation valves, the internal conduit of the at least one pin isolation valve fluidically coupled to a conduit penetrating the housing. At least one of the openings of the third and fourth pin isolation valves is sealed by a lip seal. The lip seal preferably is self-energizing. The movable member consists of at least one of (a) metal, (b) polymer, and (c) sapphire.

[0013] In a method of operating the flow through isolation valve, the valve comprises: a movable member, with the movable member having first and second conduits for interfacing with internal conduits of first and second pin isolation valves. The internal conduits open to a surface of the movable member; with first and second blank openings for interfacing with the internal conduits of the first and second pin isolation valves,

(A) wherein the valve is in an initial position of flow isolation such that at least one of (a) the first pin isolation valve providing fluid flow interfaces with the first blank opening and (b) the second pin isolation valve exhausting the fluid flow interfaces with the second blank opening, the method comprises the steps of: (I) wherein the first pin isolation valve interfaces with the first blank opening, (1) moving said first pin isolation valve away

from the first blank opening, (2) moving the movable member, and (3) moving the first pin isolation valve towards the movable member such that the internal conduit within the first pin isolation valve interfaces with the first conduit opening to a surface of the movable member; and (II) wherein the second pin isolation valve interfaces with the second blank opening, (1) moving the second pin isolation valve away from the second blank opening, (2) moving the movable member, and (3) moving the second pin isolation valve towards the movable member such that the internal conduit within the second pin isolation valve interfaces with the second conduit opening to a surface of the movable member. In (B) wherein the valve is in an initial position of flow throughput such that at least one of (a) the first pin isolation valve providing fluid flow interfaces with the first conduit and (b) the second pin isolation valve exhausting the fluid flow interfaces with the second conduit, the method comprises the steps of: (III) wherein the first pin isolation valve interfaces with the first conduit, (1) moving the first pin isolation valve away from the first conduit, (2) moving the movable member, and (3) moving the first pin isolation valve towards the movable member such that the internal conduit within the first pin isolation valve interfaces with the first blank opening; and (IV) wherein the second pin isolation valve interfaces with the second conduit, (1) moving the second pin isolation valve away from the second conduit, (2) moving the movable member, and (3) moving the second pin isolation valve towards the movable member such that the internal conduit within the second pin isolation valve interfaces with the second blank opening.

[0014] The method can be applied wherein the flow through isolation valve supplies fluid flow to a high pressure liquid chromatography (HPLC) system, wherein the system comprises the flow through isolation valve, and a face seal valve, with the face seal valve having a first port for receiving high pressure fluid, a second port capable of being fluidically coupled to at least one of the first port and to an inlet end of a sample loop, a third port capable of being fluidically coupled to a sample supply and to at least one of the inlet end of the sample loop and to a fourth port capable of being fluidically coupled to a syringe for aspirating the sample, a fifth port capable of being fluidically coupled to

at least one of the fourth port and to an outlet end of the sample loop, and to a sixth port for discharging high pressure fluid, the flow through isolation valve fluidically coupled to the face seal valve by means of a first conduit coupling the first port and the first conduit and by means of a second conduit coupling the sixth port and the second conduit, the method further comprises the steps of: (A') during a load phase wherein the flow through isolation valve is in an initial position of flow isolation: (1') coupling the second port to the third port, (2') coupling the fifth port to the fourth port, and (3') aspirating sample liquid into the sample loop by operating the syringe. In (B') a transition phase wherein the flow through isolation valve remains in the initial position of flow isolation, the method further comprises the steps of: (1') transferring coupling of the second port from the third port to the first port for receiving high pressure liquid, and (2') transferring coupling of the fifth port from the fourth port to the sixth port for discharging high pressure liquid. In (C') during an injection phase wherein the face seal valve is in a position of flow throughput through the sample loop and (I) wherein the first pin isolation valve interfaces with the first blank opening, the method further comprises the steps of: (1) moving the first pin isolation valve away from the first blank opening; (2) moving the movable member; and (3) moving the first pin isolation valve towards the movable member such that the internal conduit within the first pin isolation valve interfaces with the first conduit opening to a surface of the movable member; and (II) wherein the second pin isolation valve interfaces with the second blank opening, (1) moving the second pin isolation valve away from the second blank opening; (2) moving the movable member; and (3) moving the second pin isolation valve towards the movable member such that the internal conduit within the second pin isolation valve interfaces with the second conduit opening to a surface of the movable member.

[0015] Following (C') the injection phase wherein the face seal valve is in a position of flow throughput through the sample loop, the method can further comprise the steps of: (B) wherein the flow through isolation valve is in an initial position of flow throughput such that at least one of (a) the first pin isolation valve providing fluid flow interfaces

with the first conduit and (b) the second pin isolation valve exhausting the fluid flow interfaces with the second conduit, and (III) wherein the first pin isolation valve interfaces with the first conduit, (1) moving the first pin isolation valve away from the first conduit; (2) moving the movable member; and (3) moving the first pin isolation valve towards the movable member such that the internal conduit within the first pin isolation valve interfaces with the first blank opening; and (IV) wherein the second pin isolation valve interfaces with the second conduit, (1) moving the second pin isolation valve away from the second conduit; (2) moving the movable member; and (3) moving the second pin isolation valve towards the movable member such that the internal conduit within the second pin isolation valve interfaces with the second blank opening.

[0016] Following (B') the transition phase wherein the face seal valve is in a position of flow throughput through the sample loop, the method can further comprise the steps of: (1'') transferring coupling of the fifth port from the sixth port to the fourth port, and (2'') transferring coupling of the second port from the first port to the third port. and the step of: (3'') aspirating sample liquid into the sample loop by operating the syringe. The method can further comprise, wherein the steps (A) wherein the valve is in an initial position of flow isolation and (I) wherein the first pin isolation valve interfaces with the first blank opening, and (II) wherein the second pin isolation valve interfaces with the second blank opening, the steps of: (1) moving the first pin isolation valve away from the first blank opening and moving the second pin isolation valve away from the second blank opening are performed simultaneously; and (2) moving the movable member; so that (3) moving the first pin isolation valve towards the movable member such that the internal conduit within the first pin isolation valve interfaces with the first conduit opening to a surface of the movable member and moving the second pin isolation valve towards the movable member such that the internal conduit within the second pin isolation valve interfaces with the second conduit opening to a surface of the movable member are performed simultaneously. The method can further comprise, wherein the steps (B) wherein the valve is in an initial position of flow throughput and (III) wherein

the first pin isolation valve interfaces with the first conduit, and (IV) wherein the second pin isolation valve interfaces with the second conduit, the steps of: (1) moving the first pin isolation valve away from the first conduit and moving the second pin isolation valve away from the second conduit are performed simultaneously, and (2) moving the movable member, so that (3) moving the first pin isolation valve towards the movable member such that the internal conduit within the first pin isolation valve interfaces with the first blank opening and moving the second pin isolation valve towards the movable member such that the internal conduit within the second pin isolation valve interfaces with the second blank opening are performed simultaneously.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] These and other features, benefits and advantages of the present invention will become apparent by reference to the following text and figures, with like reference numbers referring to like structures across the views, wherein:

[0018] FIG. 1A illustrates a partial embodiment of the flow-through isolation valve of the present invention in a load phase as it interfaces with a face seal valve.

[0019] FIG. 1B illustrates a partial embodiment of the flow through isolation valve of FIG. 1A in the transition phase.

[0020] FIG. 1C illustrates a partial embodiment of the flow through isolation valve of FIG. 1A in the injection phase.

[0021] FIG. 2 is a perspective view of the rotor of the partial embodiment of the flow-through isolation valve of FIGS. 1A-1C.

[0022] FIG. 3A is an end elevation view of the rotor of the flow-through isolation valve of FIG. 2.

[0023] FIG. 3B is a plan view of the rotor of the flow-through isolation valve of FIG. 2.

[0024] FIG. 3C is a cross-section view taken along the centerline 3C-3C' of FIG. 3C.

[0025] FIG. 4 is an exploded view of the rotor and stators and other components of a first variation of the partial embodiment of the flow-through isolation valve of FIGS. 1A-1C.

[0026] FIG. 5 is a perspective view of a complete embodiment of a second variation of the flow-through isolation valve of the present invention.

[0027] FIG. 5A is a side elevation view of the flow through isolation valve of FIG. 5.

[0028] FIG. 5B is an end elevation view of the flow through isolation valve of FIG. 5A.

[0029] FIG. 5C is a cross-section view taken along the cross-section line 5C-5C' of FIG. 5A.

[0030] FIG. 6A illustrates a perspective view of a partial second embodiment of a flow-through isolation valve of the present invention.

[0031] FIG. 6B is a cross sectional perspective view of the partial second embodiment of the present invention as taken along cross-section line **6B-6B'** of FIG. 6A.

[0032] FIG. 7 is a cross sectional elevation view of a third embodiment of the present invention of a linear flow through isolation valve **300** which interfaces with a face seal valve.

[0033] FIG. 8 is a cross sectional elevation view of a fourth embodiment of the present invention of a linear flow through isolation valve which has a configuration similar to the generally cylindrically shaped second embodiment of rotor illustrated in FIGS. 6A and 6B.

DETAILED DESCRIPTION OF THE INVENTION

[0034] This application incorporates by reference concurrently filed co-pending provisional application Serial No. (Attorney Docket No. WAA-359).

[0035] The present invention describes an isolation valve and rotor for use in high pressure fluid systems that permits switching to another flow path without temporarily blocking flow as would occur in face-shear valves as are customarily used in high pressure fluid systems, in particular in high pressure liquid chromatography. The valve and rotor allow for high pressure injections from a face-shear valve to a column without disrupting fluid flow. The sample fluid injection circuit may be isolated from the remainder of the HPLC system. The isolation valve includes a housing having a bore therethrough and a cylindrical rotor rotatable within the bore.

[0036] The bore wall includes two axially spaced holes. The first hole serves as an input to the sample injector or valve and the second hole serves as an outlet from the sample

injector or valve. The rotor includes a first end for delivering fluid from a pump and a second end for receiving fluid from the sample circuit.

[0037] On the outer surface of the rotor are a first port for receiving fluid from the pump, the port being fluidically coupled to the first end for delivering fluid from the pump, and a second port for delivering the fluid received from the sample circuit to a HPLC column, the second port being fluidically coupled to the second end for receiving fluid from the sample circuit. The rotor also includes a pair of axially spaced ports that register with the first and second ports of the housing bore when the rotor is positioned in a fluid flow position. Although the ports are preferably offset by an angle of about 90° from each other on the outer surface of the rotor, the ports can be aligned to be adjacent to each other.

[0038] A bore that is typically at right angles extends in the rotor between the first end and the first port of the pair of axially spaced ports of the rotor and another bore that is typically at right angles extends in the rotor between the second end and the second port of the pair of axially spaced ports of the rotor. Both the first end and second end of the rotor are each further provided with an axially spaced fluid stop port positioned preferably at a 45° angle relative to the pair of axially spaced ports.

[0039] When the rotor is in its fluid flow position, fluid flows from a pump, through the isolation valve, to the sample injector circuit, back through another portion of the valve, and then to a column. By turning the rotor preferably 90°, the fluid stop ports prevent the flow of fluid and isolate the sample circuit from the remainder of the HPLC system.

[0040] In particular, in FIG. 1A, a conventional face seal valve 10 has six ports 1, 2, 3, 4, 5 and 6. As shown, port 1 is supplied from the high pressure pump (not shown), port 2

interfaces with one end of sample loop 20 such that the other end of the loop 20 interfaces with port 5. Port 3 interfaces with a sample supply tube 24 while port 4 interfaces with syringe tube 26. Port 6 is coupled to the HPLC capillary column (not shown). The face seal valve 10 rotates clockwise or counterclockwise to switch between adjacent port connections as is known to those skilled in the art. In FIG. 1A, the face seal valve 10 is in the load position since sample supply tube 24 is in an interface position through port 3 which is fluidically coupled through port 2 with one end of the loop 20. The other end of the loop 20 is fluidically coupled through port 5 and port 4 to the syringe 26

[0041] In a partial embodiment of the present invention of a flow through isolation valve 100, during the load phase, the loop 20 is disconnected from high pressure fluid that otherwise flows to port 1 from conduit tubing 32. The conduit tubing 32 is preferably flexible at least along one end 42 which interfaces with internal conduit 58 within pin isolation valve 56. Coupling 62 couples the flexible tube 42 to pin isolation valve 56. During the load phase, the pin isolation valve 56 is positioned to interface with a blank port 88 on a side of a rotor 50. The rotor 50 has a centerline axis of rotation 100CL. Sample fluid is provided from a high pressure pump (not shown) through pin 34 by way of internal conduit 38. The pin 34 is in direct contact with rotor 50 at port 52. During the load phase, the internal conduit 38 provides high pressure fluid through internal conduit 40 within the rotor 50 to an open port 60 that is fluidically coupled to an annular passageway 84. Since the pin isolation valve 56 interfaces with the blank port 88, flow of high pressure fluid from the high pressure pump to the port 1 of the face seal valve 10 is effectively isolated.

[0042] Similarly, flow from the face seal valve 10 from port 6 would otherwise discharge to the capillary column at port 6 into conduit tubing 66. The conduit tubing 66 also is

preferably flexible at least along one end **22** which interfaces with internal conduit **82** within pin isolation valve **78**. Conduit tubing **66** is coupled to pin isolation valve **78** by means of coupling **70**. During the load phase, the pin isolation valve **78** is positioned to interface with a blank port **92** on the opposite side of the rotor **50**. Internal conduit **76** within the rotor **50** permits the flow of fluid to flow through the HPLC column isolation pin valve **98** where the internal conduit **76** fluidically couples to an internal conduit **96** within the column isolation pin **98**. The internal conduit **76** has a port **80** on the same side of the rotor **50** as blank port **92**. During the load phase, since the pin isolation valve **78** interfaces with the blank port **92** rather than the open port **80**, flow to the HPLC column through isolation pin valve **98** is effectively isolated.

[0043] In addition to annular passageway **84**, annular passageway **86** is provided on the same side of the rotor **50** as open port **80** to permit the flow of fluid from the pump directly to the column by way of internal rotor passageway **90**.

[0044] Therefore, during the load phase, the flow through isolation valve **100**, having effectively isolated the high pressure fluid from the high pressure pump and flow to the column, permits the face seal valve **10** to be turned freely without being subject to high pressures. Due to the high operating pressure, to prevent external leakage, the pin isolation valves **34** and **98** are rigidly inserted into ports **52** and **74** in a manner so as to substantially prevent external leakage by means known to those skilled in the art.

[0045] FIG. **1B** illustrates a partial embodiment of the flow through isolation valve **100** in the transition phase. The transition phase is an intermediate phase between the load phase and the inject phase. During the transition phase, the position and orientation of the flow through isolation valve **100** remains the same as in the load phase described previously for FIG. **1A**. However, port **1** of the face seal valve **10** is now fluidically

coupled to one end of the loop 20 at port 2 while the other end at port 5 is fluidically coupled to port 6.

[0046] FIG. 1C illustrates a partial embodiment of the flow through isolation valve 100 in the injection phase. In the inject phase, the position and orientation of the face seal valve 10 remains the same as during the transition phase. However, the position and orientation of the flow through isolation valve 100 are changed as follows. The rotor 50 is rotated preferably 90° about the centerline axis of rotation 100CL. The pin isolation valve 56 is positioned to interface with port 60 so that internal conduit 58 within the pin isolation valve 56 is in fluidic communication with the internal conduit 40 of the rotor 50. Therefore, the high pressure liquid originating from pin isolation valve 34 is now in fluidic communication with ports 1 and 2 and the loop 20 of the face seal valve 10. Correspondingly, the pin isolation valve 78 is positioned to interface with port 80 so that internal conduit 76 within the pin isolation valve 78 is fluidically coupled with the loop 20 through ports 5 and 6 thereby enabling injection of high pressure fluid to the column through the internal conduit 96 within pin isolation valve 98.

[0047] Those skilled in the art recognize that following the inject phase illustrated in FIG. 1C, the flow through isolation valve 100 can be returned to the load phase by reversing the operation back to the transition phase illustrated in FIG. 1B and subsequently to the load phase illustrated in FIG. 1A.

[0048] FIG. 2 is a perspective view of the rotor 50 showing the ports 52 and 74 at least one of which is typically oriented on the upper portion of the outer surface of the rotor 50. Although ports 52 and 74 can be aligned on the upper portion of the outer surface of the rotor 50 to be immediately adjacent to each other, because ports 52 and 74 preferably include connections necessary to prevent external leakage and also because of the need

for seals to be positioned for pin isolation valves **34** and **98**, ports **52** and **74** are preferably offset from each other by 90° . Port **52** permits flow from the high pressure pump to the port **60**. Corresponding port **80** on the opposite end (not shown) permits flow through the port **74** and onward to the face seal valve **10**. The blank port **88** is provided and is typically positioned such that the angle formed by port **60**, rotor center point **100CL**, and blank port **88** is 90° . When the pin **56**, that allows flow from the pump, is moved away from port **60**, the rotor **50** can be rotated 90° so that the pin **56** can then be inserted into blank port **88**, thereby isolating flow of fluid from the pump. Fluid can then circulate through the annular passageway **84** as is described later.

[0049] FIG. 3A is an end view of the rotor **50** of FIG. 2 showing the port **60** that receives flow from the high pressure pump, the blank port **88**, the internal rotor passageway **90**, and the annular passageway **84**.

[0050] FIG. 3B is a plan view of the rotor **50** of FIG. 2. The ports **52** and **74** appear in plan view.

[0051] FIG. 3C is a cross-section view of the rotor **50** taken along the centerline **3C-3C** of FIG. 3B.. Ports **52** and **60** are shown coupled by internal conduit **40**, while internal conduit **76** couples ports **74** and **80**. Blank fluid flow stop port **88** is positioned opposite to corresponding blank fluid flow stop port **92** on the opposite end of the rotor **50**. As noted previously, annular passageways **84** and **86** provided on either end of the rotor **50** to permit the flow of fluid from the pump directly to the column by way of internal rotor passageway **90**. Because of continuous flow in the internal rotor passageway **90**, stagnant conditions do not occur typically so it is not generally necessary to provide a wash system for the internal rotor passageway **90**.

[0052] FIG. 4 is an exploded view of a portion of the components comprising a first variation of the embodiment of the flow through isolation valve 100. Pump supply pin 34 interfaces with port 52 in the rotor clamp 54 and outlet supply to column pin 98 interfaces with port 74 in the rotor clamp 54. Face seal valve supply pin 56 is surrounded by stator 120 and interfaces with one end of rotor 50 while face seal valve discharge pin 78 is surrounded by stator 122 and interfaces with the opposite end of rotor 50. During normal operation, only the pins 56 and 78 which are surrounded by the stators 120 and 122 are moved either away from or back towards the rotor 50. The pump supply pin 34 and outlet supply to column pin 98 are maintained normally in position except that they are rotated together with the rotation of the rotor 50. The rotor 50 and rotor clamp 54 are rotated around the centerline 100CL by means of drive gear 105.

[0053] When the rotor 50 is in its fluid flow position, fluid flows from a separate high pressure pump, through the isolation valve 100, to the sample injector circuit of face seal valve 10, back through another portion of the isolation valve 100, and then to a column.

[0054] When the rotor 50 is rotated around centerline 100CL by means of drive gear 105 through an angle of preferably 90°, the pins 56 and 78 are repositioned to the blank fluid flow stop ports 88 and 92 which prevent the flow of fluid and isolate the sample circuit of face seal valve 10 from the remainder of the HPLC system. Those skilled in the art recognize that the drive gear 105 can be either a separate unit from the rotor clamp 54 or else the drive gear 105 can be an integral unitary structure combined with the rotor clamp 54 and even the rotor 50. In addition, although shown as a drive gear, other means known to those skilled in the art such as, for example, an operating handle, can be employed.

[0055] FIG. 5 is a perspective view of the complete embodiment of another variation of flow-through isolation valve 100 of the present invention. The rotor 50 is surrounded by rotor clamp 54. The rotor clamp 54 is operated now by a handle 110 that is connected such that the rotor 50 can be rotated around the valve centerline 100CL. Stators 120 and 122 are positioned on opposite ends of the rotor 50.

[0056] FIG. 5A is a side elevation view of the flow through isolation valve 100 of FIG. 5. The components of valve 100 are centered around centerline 100CL. Specifically, the rotor 50 is positioned so that stators 120 and 122 are disposed on either end of the rotor 50. Belleville springs 150 and 152 deflect the axial loads along the centerline 100CL which act on the rotor 50. The Belleville springs 150 and 152 are mounted on an end of both stators 120 and 122 by means of load washers 140 and 142. The load washers are locked into position by spherical nuts 130 and 132.

[0057] FIG. 5B is an end elevation view of the flow through isolation valve 100 of FIG. 5A, which illustrates the spherical nut 132, load washer 142, and rotor handle 110.

[0058] FIG. 5C is a cross-section view taken along the cross-section line 5C-5C of FIG. 5A. The rotor 50 is sealed by a set of three sealing layers 160 and 162 set around the pins 56 and 78, respectively. The preferred materials for the sealing layers are comprised of PEEK (polyetheretherketone), PTFE (polytetrafluorethylene), and PEEK. Both sets of sealing layers 160 and 162 are restrained from the axial forces by Belleville spring washers 170 and 172, Belleville springs 150 and 152 and load washers 140 and 142, respectively. The rotor 50 is comprised preferably of PEEK or PEEK blend. The rotor clamp 54 and the stators 120 and 122 are comprised preferably of Type 316 stainless steel.

[0059] The respective valve ends **180** and **182** of the flow through isolation valve **100** can be considered to comprise the stators **120** and **122**, the sealing layers **160** and **162**, Belleville spring washers **170** and **172**, Belleville springs **150** and **152**, load washers **140** and **142**, and spherical nuts **130** and **132**.

[0060] In a second embodiment as shown in FIG. **6A**, a rotor **202** of flow-through isolation valve **200**, having an axial centerline **200CL**, comprises flow ports **206** and **208** disposed on the outer surface of the rotor **202**. FIG. **6B** is a cross-sectional view of the flow-through isolation valve **200** taken along the section line **6B-6B'** of FIG. **6A**. Fluid stop port **210**, associated with flow port **206**, and fluid stop port **212**, associated with flow port **208**, are each also disposed on the outer surface of the rotor **202**.

[0061] As compared to FIGS. **1A** to **1C**, pump isolation pin valve **34** is now mounted on one end **220** of the rotor **202** coincident with centerline **200CL**. Column isolation pin valve **68** is now mounted on the opposite end **222** of the rotor **202** also coincident with centerline **200CL**. Pin valve **34** and column valve **68** are positioned within ports **224** and **226** by means preferably of threaded compression connections **228** and **230**, respectively. Port **224** interfaces with port **206** through internal conduit **232** so that during the injection mode, pin isolation valves **34** and **56** are in fluidic communication with the pump and face seal valve **10** ports **1** and **2** to sample loop **20**.

[0062] Correspondingly, port **226** interfaces with port **208** through internal conduit **234** so that during the injection mode, pin isolation valves **68** and **78** are in fluidic communication with the face seal valve **10** ports **5** and **6** from sample loop **20** to the column.

[0063] The rotor **202** further comprises an end **240** with a flat surface **242** to enable rotation of the rotor **202** by means of, for example, a drive lever (not shown) or other operating device such as an operating handle known to those skilled in the art.

[0064] Those skilled in the art recognize that the pin isolation valves **68** and **78** are positioned to interface with stop ports **210** and **212**, respectively, during the load and transition phases and face seal valve **10** is operated in the same way as described for FIGS. **1A** and **1B**.

[0065] FIG. **7** illustrates a an elevation section view of a third embodiment of the present invention of a linear flow through isolation valve **300** which interfaces with face seal valve **10** in the same manner as shown in FIGS. **1A-1C**. The linear flow through isolation valve **300** comprises a stationary inner member **302** and a movable inner member **304**. The two members **302** and **304** interface at surface **306**. The movable member **304** slides along the surface **306** while the stationary member **302** remains in place. This embodiment differs from the first and second embodiments in that pin isolation valve **34** from the high pressure pump (not shown) is inserted into port **352** of the movable member **304** where it is sealed preferably to prevent external leakage by means known to those skilled in the art. Flow is provided from the high pressure pump to the pin isolation valve **34** by means of flexible conduit **316** and coupling **312**. The internal conduit **38** within the pin isolation valve **34** is in fluidic communication with internal conduit **340** within the movable member **304** and with an open port **360** on the interfacing surface **306**. The open port **360** is in fluidic communication with a chamber **308** within the stationary member **302** that is bordered by the interfacing surface **306**. The stationary member **302** and the movable member **304** act to seal the chamber **308**. Pin isolation valve **56** penetrates through stationary member **302** at penetration **322** such that the pin valve **56** can move linearly up and down.

[0066] By means of coupling 62, the internal conduit 58 within pin valve 56 is in fluidic communication with conduit tubing 32 to the face seal valve 10. Conduit tubing 66 from the face seal valve 10 is then fluidically coupled to the internal conduit 82 of pin isolation valve 78 by means of coupling 70. Similarly, pin isolation valve 78 penetrates through stationary member 302 at penetration 324 such that the pin valve 78 can move linearly up and down. The internal conduit 82 within pin isolation valve 78 is then in fluidic communication with the chamber 308 within the stationary member 302 that is bordered by the interfacing surface 306. The pin valve 78 is positioned to interface with open port 380 on the interfacing surface 306. The open port 380 is in fluidic communication with the chamber 308.

[0067] Those skilled in the art recognize that each of the pin isolation valves 56, 78, 34 and 98 are generally provided with the same valve ends (not shown in FIG. 7) as shown in and as described for FIGS. 5A-5C, previously.

[0068] During the injection phase, the internal conduit 82 within the pin isolation valve 78 is in fluidic communication also with internal conduit 376 within the movable member 304 and with an open port 374 on an opposite end of movable member 304. Pin isolation valve 98 is inserted into open port 374 so that the internal conduit 96 within pin valve 98 is in fluid communication with the sample loop 20 of the face seal valve 10. The internal conduit 96 within the pin isolation valve 98 is in fluidic communication with the column by means of flexible conduit 318 that is coupled to the pin valve 98 by coupling 314.

[0069] During the load phase, the pin isolation valve 78 is positioned to interface with blank port 392 on the surface 306 of movable member 304. Similarly, the pin isolation valve 56 is positioned to interface with blank port 388 on the surface 306 of movable

member **304**. These actions effectively isolate flow from the high pressure pump to the face seal valve **10** and to the column in the same manner as discussed previously for the first and second embodiments.

[0070] To counteract fluid leakage that can occur at the interfacing surface **306** between the stationary member **302** and moving member **304**, and also to balance the force tending to separate the stationary member **302** from the moving member **304** due to the pressure within the chamber **308**, one means is to provide an outer housing **350** which encloses the stationary member **302** and moving member **304**, as well as the pin isolation valves **34** and **98**. The flexible conduits **316** and **318** can penetrate the outer housing **350** through outer housing penetrations **382** and **384**, respectively. With regard to pin isolation valves **56** and **78**, either the stators **120** and **122** or the flexible conduit **32** and **66** can be enclosed by outer housing penetrations **336** and **338**, respectively. To provide the pressure equalization, the outer housing **350** can be filled with pressurized liquid or gas at a pressure equal to or slightly above the operating pressure of the fluid within the chamber **308**.

[0071] A means for moving the moving member laterally is provided such as, but not limited to, a linear motor **360** which is coupled to the moving chamber **304** enables the pins **56** and **78** to be shifted between the open ports **360** and **380** and the blank ports **388** and **392**, respectively. The linear motor **360** can be supplied electrical power from a power supply **362** with electrical connections **364** and **366** through outer housing penetrations **368** and **370**, respectively.

[0072] Another variation of the third embodiment is to design the stationary member **302** and the moving member **304** as a duplex or mirror-image design so that the moving member **304** further comprises ports and internal conduits for the pump and column, or a

second pump and column, to be capable of serving a second face seal valve simultaneously.

[0073] In a fourth embodiment, FIG. 8 illustrates linear flow through isolation valve 800 which has a configuration similar to the generally cylindrically shaped second embodiment of rotor 202 illustrated in FIGS. 6A and 6B. As before, the linear flow through isolation valve 800 is comprised of a stationary member 802 and a movable member 804. The movable member 804 is similar to the rotor 202 except that instead of moving in a rotary motion, the movable member 804 moves by sliding linearly through the stationary member 802. The movable member 804 can have any other type of cross-section such as, for example but not limited to, an oval shape or a square with smooth rounded corners. The rotary member 804 is made preferably of either a metal or a polymer or sapphire.

[0074] The stationary member 802 is comprised of two surfaces 806a and 806b which surround the movable slider member 804. The two surfaces 806a and 806b each include lip seals 808a and 808b. The stationary member 802 also forms an interfacing surface 810 surrounding the movable member

[0075] As is the case for the third embodiment, pin isolation valve 34 from the high pressure pump (not shown) is inserted into port 352 of the movable member 804 where it is sealed in a manner as to substantially prevent external leakage. Flow is provided from the high pressure pump to the pin isolation valve 34 by means of flexible conduit 316 and coupling 312. The internal conduit 38 within the pin isolation valve 34 is in fluidic communication with internal conduit 840 within the movable member 804 and with an open port 860 on the interfacing surface 810. The open port 360 is in fluidic communication with a volume of space 812 within the stationary member 802 that is

bordered by the interfacing surface **810**. The volume of space **812** within the stationary member **802** and the movable member **804** are sealed by the . Pin isolation valve **56** penetrates through stationary member **802** at penetration **822** such that the pin valve **56** can move linearly up and down.

[0076] By means of coupling **62**, the internal conduit **58** within pin valve **56** is in fluidic communication with conduit tubing **32** to the face seal valve **10** in a similar manner to the third embodiment. Conduit tubing **66** from the face seal valve **10** is then fluidically coupled to the internal conduit **82** of pin isolation valve **78** by means of coupling **70**. Similarly, pin isolation valve **78** penetrates through stationary member **802** at penetration **324** such that the pin valve **78** can move linearly up and down. The internal conduit **82** within pin isolation valve **78** is then in fluidic communication with the volume of space **812** within the stationary member **802** that is bordered by the interfacing surface **810**. The pin valve **78** is positioned to interface with open port **880** on the interfacing surface **310**. The open port **880** is in fluidic communication with the volume of space **812**.

[0077] To seal the pin isolation valves **56** and **78**, the stationary member **802** includes self-energized lip seals **820a** and **820b**, respectively. The lip seals are commercially available from Furon, Inc. of Hoosick Falls, New York.

[0078] In a similar manner to the third embodiment, during the injection phase, the internal conduit **82** within the pin isolation valve **78** is in fluidic communication also with internal conduit **876** within the movable member **804** and with an open port **374** on an opposite end of movable member **304**. Pin isolation valve **98** is inserted into open port **874** so that the internal conduit **96** within pin valve **98** is in fluid communication with the sample loop **20** of the face seal valve **10**. The internal conduit **96** within the pin isolation

valve 98 is in fluidic communication with the column by means of flexible conduit 318 that is coupled to the pin valve 98 by coupling 314.

[0079] During the load phase, the pin isolation valve 78 is positioned to interface with blank port 892 on the surface 810 of movable member 804. Similarly, the pin isolation valve 56 is positioned to interface with blank port 888 on the surface 810 of movable member 804. These actions effectively isolate flow from the high pressure pump to the face seal valve 10 and to the column in the same manner as discussed previously for the first and second embodiments.

[0080] Although described with respect to application to high pressure fluids, the first, second and third embodiments of the present invention can be applied to fluids at any operating pressure, including sub-atmospheric, i.e., vacuum applications as well.

[0081] The invention has been described herein with reference to particular exemplary embodiments. Certain alterations and modifications may be apparent to those skilled in the art, without departing from the scope of the invention. The exemplary embodiments are meant to be illustrative, not limiting of the scope of the invention, which is defined by the appended claims.

What is claimed is:

1. A flow through isolation valve, said flow through isolation valve comprising:
 - a stationary member;
 - a movable member, a surface of said stationary member interfacing with a surface of said movable member; and
 - at least one pin isolation valve;said at least one pin isolation valve having a flow through internal conduit,
said at least one pin isolation valve movably disposed so that said internal conduit is capable of fluidically communicating with at least one blank opening in said movable member,
said at least one pin isolation valve movably disposed so that said internal conduit within said pin isolation valve is capable of fluidically communicating with a flow through conduit in said movable member.
2. The flow through isolation valve according to claim 1, wherein said movable member moves by rotation around an axis of rotation.
3. The flow through isolation valve according to claim 1, wherein said movable member moves by at least one of linear and curvilinear translation.
4. The flow through isolation valve according to claim 1, wherein one of said at least one pin isolation valves is fluidically coupled to a sample loop of a face seal valve of a high pressure liquid chromatography (HPLC) system.
5. The flow through isolation valve according to claim 1, wherein one of said at least one pin isolation valves is fluidically coupled to a pump supplying

high pressure liquid to a face seal valve of a high pressure liquid chromatography (HPLC) system.

6. The flow through isolation valve according to claim 1, wherein one of said at least one pin isolation valves is fluidically coupled to a column discharging high pressure liquid from a face seal valve of a high pressure liquid chromatography (HPLC) system:

7. A flow through isolation valve,
said isolation valve disposed around an axis of rotation,
said isolation valve comprising:
at least two opposing valve ends disposed around
said axis of rotation;
a rotor disposed between said valve ends, an axis of
rotation of said rotor being one of parallel and coincident with the axis of rotation
of said isolation valve, said rotor disposed such that orientation of said rotor can
change by rotation around the axis of rotation of said rotor, said rotor having
an outer surface having at least first and second openings on said outer
surface,
at least two surfaces each intersecting said outer surface,
a flow-through conduit having an opening on a first of said at least two
surfaces intersecting said outer surface and an opening on a second of said at least
two surfaces intersecting said outer surface;
a flow through conduit having an opening on said outer surface coincident
with said first opening on said outer surface and an opening on said first of said at
least two surfaces intersecting said outer surface,

a flow through conduit having an opening on said outer surface coincident with said second opening on said outer surface and an opening on said second of said at least two surfaces intersecting said outer surface,

at least one blank opening on said first of said at least two surfaces intersecting said outer surface,

at least one blank opening on said second of said at least two surfaces intersecting said outer surface,

a first sealing annulus for sealing said openings on said first of said at least two surfaces intersecting said outer surface, and

a second sealing annulus for sealing said openings on said second of said at least two surfaces intersecting said outer surface;

a first pin isolation valve having an internal conduit, said first pin isolation valve disposed to move along said axis of rotation of said isolation valve through one of said valve ends;

said first pin isolation valve movably disposed so that said internal conduit is capable of fluidically communicating with said at least one blank opening on said first of said at least two surfaces intersecting said outer surface,

said first pin isolation valve movably disposed so that said internal conduit is capable of fluidically communicating with said flow through internal conduit having an opening on said outer surface and an opening on a second of said at least two surfaces intersecting said outer surface;

a second pin isolation valve, said second pin isolation valve disposed to move along the axis of rotation of said isolation valve through another one of said valve ends, said pin isolation valve including an internal conduit;

said second pin isolation valve movably disposed so that said internal conduit is capable of fluidically communicating with said at least one blank

opening on said second of said at least two surfaces intersecting said outer surface,

said second pin isolation valve movably disposed so that said internal conduit within said second pin isolation valve is capable of fluidically communicating with said flow through conduit having an opening on said outer surface and an opening on said second of said at least two surfaces intersecting said outer surface.

8. The flow through isolation valve according to claim 7, wherein the axis of rotation of said rotor is the centerline of said rotor.

9. The flow through isolation valve according to claim 7, wherein the axis of rotation of said isolation valve is the centerline of said isolation valve.

10. The flow through isolation valve according to claim 7, wherein said rotor further comprises:

a rotor clamp having an outer surface and an inner surface, the inner surface surrounding at least a portion of the outer surface of said rotor,

a first opening on the outer surface of said rotor clamp penetrating said rotor clamp to coincide with said first opening on the outer surface of said rotor, and

a second opening on the outer surface of said rotor clamp penetrating said rotor clamp to coincide with the second opening on the outer surface of said rotor.

11. The flow through isolation valve according to claim 10, further comprising at least one of a (a) third pin isolation valve, and (b) fourth pin isolation valve;

said third pin isolation valve having an internal conduit, said third pin isolation valve disposed within said first opening on said outer surface of said rotor clamp so that said internal conduit of said third pin isolation valve is disposed to be in fluidic communication with said opening on the outer surface of said flow through conduit having an opening on the outer surface and an opening on the first of said at least two surfaces intersecting the outer surface of said rotor,

said fourth pin isolation valve having an internal conduit, said fourth pin isolation valve disposed within said second opening on the outer surface of said rotor clamp so that said internal conduit of said fourth pin isolation valve is disposed to be in fluidic communication with said opening on the outer surface of said flow through conduit having an opening on the outer surface and an opening on said second of said at least two surfaces intersecting the outer surface of said rotor.

12. The flow through isolation valve according to claim 10, wherein said rotor clamp further comprises drive means for driving said rotor to rotate around the axis of rotation of said rotor.

13. The flow through isolation valve according to claim 12, wherein said rotor clamp drive means comprises a gear drive operator.

14. The flow through isolation valve according to claim 12, wherein said rotor clamp drive means comprises a handle operator.

15. The flow through isolation valve according to claim 7, wherein at least one of said valve ends comprises:

a stator enclosing the at least one pin isolation valve,

said stator adjacent to said rotor;
a sealing layer enclosed within said stator and enclosing said at least one pin isolation valve for sealing said at least one pin isolation valve;
a Belleville spring washer;
a Belleville spring;
a load washer; and
a spherical nut,
said Belleville spring washer, said Belleville spring, said load washer and said spherical nut axially arranged to impose an axial force for sealing said sealing layer enclosing said pin isolation valve.

16. The flow through isolation valve according to claim 15, wherein said sealing layer is comprised of at least one of PEEK (polyetheretherketone) and PTFE (polytetrafluorethylene)

17. The flow through isolation valve according to claim 7, wherein said rotor is comprised of PEEK blend.

18. The flow through isolation valve according to claim 8, wherein said rotor clamp is comprised of stainless steel.

19. The flow through isolation valve according to claim 18, wherein said stainless steel is Type 316 stainless steel.

20. The flow through isolation valve according to claim 7, wherein either of said first and second pin isolation valves is fluidically coupled to a sample loop of a face seal valve of a high pressure liquid chromatography (HPLC) system.

21. The flow through isolation valve according to claim 11, wherein either of said third and fourth pin isolation valves is fluidically coupled to a pump supplying high pressure liquid to a face seal valve of a high pressure liquid chromatography (HPLC) system.

22. The flow through isolation valve according to claim 11, wherein either of said third and fourth pin isolation valves is fluidically coupled to a column discharging high pressure liquid from a face seal valve of a high pressure liquid chromatography (HPLC) system.

23. A rotor for a flow through isolation valve,
said isolation valve disposed around an axis of rotation, said
isolation valve comprising:
at least two opposing valve ends disposed around said axis of
rotation;
said rotor disposed between said valve ends, an axis of rotation of
said rotor being substantially parallel and coincident with the axis of rotation of said
isolation valve, said rotor disposed such that orientation of said rotor can change by
rotation around the axis of rotation of said rotor, said rotor having
an outer surface;
at least two surfaces each intersecting said outer surface;
a flow-through conduit having an opening on a first of said at least two
surfaces intersecting said outer surface and an opening on a second of said at least
two surfaces intersecting said outer surface;
and at least one of

(a) a flow through conduit having an opening on said outer surface coincident with said first opening on said outer surface and an opening on the first of the at least two surfaces intersecting said outer surface; and

(b) a flow through conduit having an opening on the outer surface coincident with said second opening on the outer surface and an opening on the second of said at least two surfaces intersecting said outer surface.

24. The rotor according to claim 23, further comprising
at least one blank opening on the outer surface.

25. The rotor according to claim 23, further comprising a sealing annulus for sealing said openings on at least one of the first of and second of said at least two surfaces intersecting said outer surface.

26. The rotor according to claim 23, further comprising
a rotor clamp having an outer surface and an inner surface, the inner surface surrounding at least a portion of the outer surface of said rotor; and
an opening on the outer surface of said rotor clamp penetrating said rotor clamp to coincide with said at least one of a first opening and a second opening on the outer surface of said rotor.

27. The rotor according to claim 23, wherein said rotor is comprised of PEEK (polyetheretherketone) blend.

28. A flow through isolation valve, said isolation valve comprising
a stationary member;
a movable member;

said stationary member and said movable member interfacing at a surface, said movable member disposed to slide along said surface;

a chamber disposed between said stationary member and said movable member, said chamber bounded by said surface;

said movable member having a first flow through conduit having an opening interfacing with said chamber and an opening on a surface of said movable member not interfacing with said chamber,

said movable member having a second flow through conduit having an opening interfacing with said chamber and an opening on a surface of said movable member not interfacing with said chamber,

a first blank opening on said surface bounding said chamber, and

a second blank opening on said surface bounding said chamber.

29. The flow through isolation valve according to claim 28, further comprising:

a first pin isolation valve having an internal conduit, said first pin isolation valve disposed within said opening of said first flow through conduit on a surface of said movable member not interfacing with said chamber, said internal conduit of said first pin isolation valve capable of fluidically communicating with said first flow through conduit; and

a second pin isolation valve having an internal conduit, said second pin isolation valve disposed within said opening of said second flow through conduit on a surface of said movable member not interfacing with said chamber, said internal conduit of said second pin isolation valve capable of fluidically communicating with said second flow through conduit.

30. The flow through isolation valve according to claim 29, further comprising at least one of a (a) third pin isolation valve, and (b) fourth pin isolation valve;

said third pin isolation valve having an internal conduit,
said third pin isolation valve disposed within an opening within said stationary member interfacing with said chamber so that said internal conduit of said third pin isolation valve is movably disposed to be in fluidic communication with said opening interfacing with said chamber and an opening on a surface of said stationary member not interfacing with said chamber,

said internal conduit of said third pin isolation valve movably disposed to be in fluidic communication with said first blank opening on said surface bounding said chamber,

said fourth pin isolation valve having an internal conduit,

said fourth pin isolation valve disposed within an opening within said stationary member interfacing with said chamber so that said internal conduit of said fourth pin isolation valve is movably disposed to be in fluidic communication with said opening interfacing with said chamber and an opening on a surface of said stationary member not interfacing with said chamber.

said internal conduit of said fourth pin isolation valve movably disposed to be in fluidic communication with said second blank opening on said surface bounding said chamber.

31. The flow through isolation valve according to claim 28, further comprising a housing enclosing said stationary member and said movable member.

32. The flow through isolation valve according to claim 30, further comprising a housing enclosing said stationary member and said movable member and at least one of said pin isolation valves, said internal conduit of said at least one pin isolation valve fluidically coupled to a conduit penetrating said housing.

33. The flow through isolation valve according to claim 28, wherein said movable member is moved by a linear electric motor.

34. The flow through isolation valve according to claim 28, wherein either of said first and second pin isolation valves is fluidically coupled to a sample loop of a face seal valve of a high pressure liquid chromatography (HPLC) system.

35. The flow through isolation valve according to claim 30, wherein either of said third and fourth pin isolation valves is fluidically coupled to a pump supplying high pressure liquid to a face seal valve of a high pressure liquid chromatography (HPLC) system.

36. The flow through isolation valve according to claim 30, wherein either of said third and fourth pin isolation valves is fluidically coupled to a column discharging high pressure liquid from a face seal valve of a high pressure liquid chromatography (HPLC) system.

37. The flow through isolation valve according to claim 31, wherein said housing is capable of retaining pressure greater than atmospheric pressure.

38. The flow through isolation valve according to claim 32, wherein said housing is capable of retaining pressure greater than atmospheric pressure.
39. The flow through isolation valve according to claim 28, wherein said movable member is comprised of PEEK (polyetheretherketone) blend.
40. The flow through isolation valve according to claim 28, wherein said interfacing surface between said stationary member and said movable member is sealed by at least one lip seal.
41. The flow through isolation valve according to claim 30, wherein at least one of said openings of said third and fourth pin isolation valves is sealed by a lip seal.
42. The flow through isolation valve according to claim 40, wherein said lip seal is self-energizing.
43. The flow through isolation valve according to claim 41, wherein said lip seal is self-energizing.
44. The flow through isolation valve according to claim 28, wherein said movable member consists of at least one of (a) metal, (b) polymer, and (c) sapphire.
45. A method of operating a flow through isolation valve, the valve comprising:
a movable member, the movable member having

first and second conduits for interfacing with internal conduits of first and second pin isolation valves,

said conduits opening to a surface of said movable member ;

first and second blank openings for interfacing with said internal conduits of said first and second pin isolation valves,

(A) wherein the valve is in an initial position of flow isolation such that at least one of (a) said first pin isolation valve providing fluid flow interfaces with said first blank opening and (b) said second pin isolation valve exhausting said fluid flow interfaces with said second blank opening,

the method comprising the steps of:

(I) wherein said first pin isolation valve interfaces with said first blank opening,

(1) moving said first pin isolation valve away from said first blank opening,

(2) moving said movable member, and

(3) moving said first pin isolation valve towards said movable member such that said internal conduit within said first pin isolation valve interfaces with said first conduit opening to a surface of said movable member; and

(II) wherein said second pin isolation valve interfaces with said second blank opening,

(1) moving said second pin isolation valve away from said second blank opening,

(2) moving said movable member, and

(3) moving said second pin isolation valve towards said movable member such that said internal conduit within said second pin isolation valve interfaces with said second conduit opening to a surface of said movable member, and

(B) wherein the valve is in an initial position of flow throughput such that at least one of (a) said first pin isolation valve providing fluid flow interfaces with said first conduit and (b) said second pin isolation valve exhausting said flow interfaces with said second conduit, the method comprising the steps of:

(III) wherein said first pin isolation valve interfaces with said first conduit,

- (1) moving said first pin isolation valve away from said first conduit,
- (2) moving said movable member, and
- (3) moving said first pin isolation valve towards said movable member such that said internal conduit within said first pin isolation valve interfaces with said first blank opening; and

(IV) wherein said second pin isolation valve interfaces with said second conduit,

- (1) moving said second pin isolation valve away from said second conduit,
- (2) moving said movable member, and
- (3) moving said second pin isolation valve towards said movable member such that said internal conduit within said second pin isolation valve interfaces with said second blank opening.

46. The method of operating a flow through isolation valve according to claim 45, wherein said flow through isolation valve supplies fluid flow to a high pressure liquid chromatography (HPLC) system, the system comprising

- said flow through isolation valve, and
- a face seal valve, said face seal valve having
- a first port for receiving high pressure fluid,
- a second port capable of being fluidically coupled to at least one of said first port and to an inlet end of a sample loop,

a third port capable of being fluidically coupled to a sample supply and to at least one of said inlet end of said sample loop and to a fourth port capable of being fluidically coupled to a syringe for aspirating the sample,

a fifth port capable of being fluidically coupled to at least one of said fourth port and to an outlet end of said sample loop, and to a sixth port for discharging high pressure fluid,

said flow through isolation valve fluidically coupled to said face seal valve by means of a first conduit coupling said first port and said first conduit and by means of a second conduit coupling said sixth port and said second conduit, the method further comprising the steps of:

(A') during a load phase wherein said flow through isolation valve is in an initial position of flow isolation:

(1') coupling said second port to said third port,

(2') coupling said fifth port to said fourth port,

and

(3') aspirating sample liquid into said sample loop by operating the syringe,

(B') a transition phase wherein said flow through isolation valve remains in the initial position of flow isolation:

(1') transferring coupling of said second port from said third port to said first port for receiving high pressure liquid, and

(2') transferring coupling of said fifth port from said fourth port to said sixth port for discharging high pressure liquid; and

(C') during an injection phase wherein said face seal valve is in a position of flow throughput through said sample loop and

(I) wherein said first pin isolation valve interfaces with said first blank opening:

- (1) moving said first pin isolation valve away from said first blank opening,
- (2) moving said movable member, and
- (3) moving said first pin isolation valve towards said movable member such that said internal conduit within said first pin isolation valve interfaces with said first conduit opening to a surface of said movable member; and
- (II) wherein said second pin isolation valve interfaces with said second blank opening,
 - (1) moving said second pin isolation valve away from said second blank opening,
 - (2) moving said movable member, and
 - (3) moving said second pin isolation valve towards said movable member such that said internal conduit within said second pin isolation valve interfaces with said second conduit opening to a surface of said movable member.

47. The method according to claim 46, wherein following (C') the injection phase wherein said face seal valve is in a position of flow throughput through said sample loop, the method further comprising the steps of:

- (B) wherein the flow through isolation valve is in an initial position of flow throughput such that at least one of (a) said first pin isolation valve providing fluid flow interfaces with said first conduit and (b) said second pin isolation valve exhausting said fluid flow interfaces with said second conduit, and
- (III) wherein said first pin isolation valve interfaces with said first conduit,
 - (1) moving said first pin isolation valve away from said first conduit,
 - (2) moving said movable member, and

(3) moving said first pin isolation valve towards said movable member such that said internal conduit within said first pin isolation valve interfaces with said first blank opening; and

(IV) wherein said second pin isolation valve interfaces with said second conduit,

(1) moving said second pin isolation valve away from said second conduit,

(2) moving said movable member, and

(3) moving said second pin isolation valve towards said movable member such that said internal conduit within said second pin isolation valve interfaces with said second blank opening.

48. The method according to claim 47, wherein following (B') the transition phase wherein said face seal valve is in a position of flow throughput through said sample loop, the method further comprising the steps of:

(1'') transferring coupling of said fifth port from said sixth port to said fourth port, and

(2'') transferring coupling of said second port from said first port to said third port.

49. The method according to claim 48, further comprising the step of:

(3'') aspirating sample liquid into said sample loop by operating the syringe.

50. The method according to claim 45, wherein said steps (A) wherein the valve is in an initial position of flow isolation and

(I) wherein said first pin isolation valve interfaces with said first blank opening, and (II) wherein said second pin isolation valve interfaces with said second blank opening, the steps of

(1) moving said first pin isolation valve away from said first blank opening and moving said second pin isolation valve away from said second blank opening are performed simultaneously, and

(2) moving said movable member, so that

(3) moving said first pin isolation valve towards said movable member such that said internal conduit within said first pin isolation valve interfaces with said first conduit opening to a surface of said movable member and

moving said second pin isolation valve towards said movable member such that said internal conduit within said second pin isolation valve interfaces with said second conduit opening to a surface of said movable member are performed simultaneously.

51. The method according to claim 45, wherein said steps (B) wherein the valve is in an initial position of flow throughput and

(III) wherein said first pin isolation valve interfaces with said first conduit, and (IV) wherein said second pin isolation valve interfaces with said second conduit, further comprising the steps of:

(1) moving said first pin isolation valve away from said first conduit and moving said second pin isolation valve away from said second conduit are performed simultaneously, and

(2) moving said movable member, so that

(3) moving said first pin isolation valve towards said movable member such that said internal conduit within said first pin isolation valve interfaces with said first blank opening and moving said second pin isolation valve towards said movable member such that said internal conduit within said second pin isolation valve interfaces with said second blank opening are performed simultaneously.

ABSTRACT

A flow through isolation valve having a stationary member;
a movable member, with a surface of the stationary member interfacing with a surface of the movable member; and at least one pin isolation valve. The pin isolation valve has a flow through internal conduit and is movable so that the internal conduit can fluidically communicate with at least one blank opening in the movable member and with a flow through internal conduit in the movable member. Movement is by rotation, linear or curvilinear translation. At least one pin isolation valve is fluidically coupled typically to a sample loop of a face seal valve, or to a pump supplying high pressure liquid to or to a column discharging liquid from a face seal valve of a high pressure liquid chromatography (HPLC) system or directly to the face seal valve.

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FIG. 1A

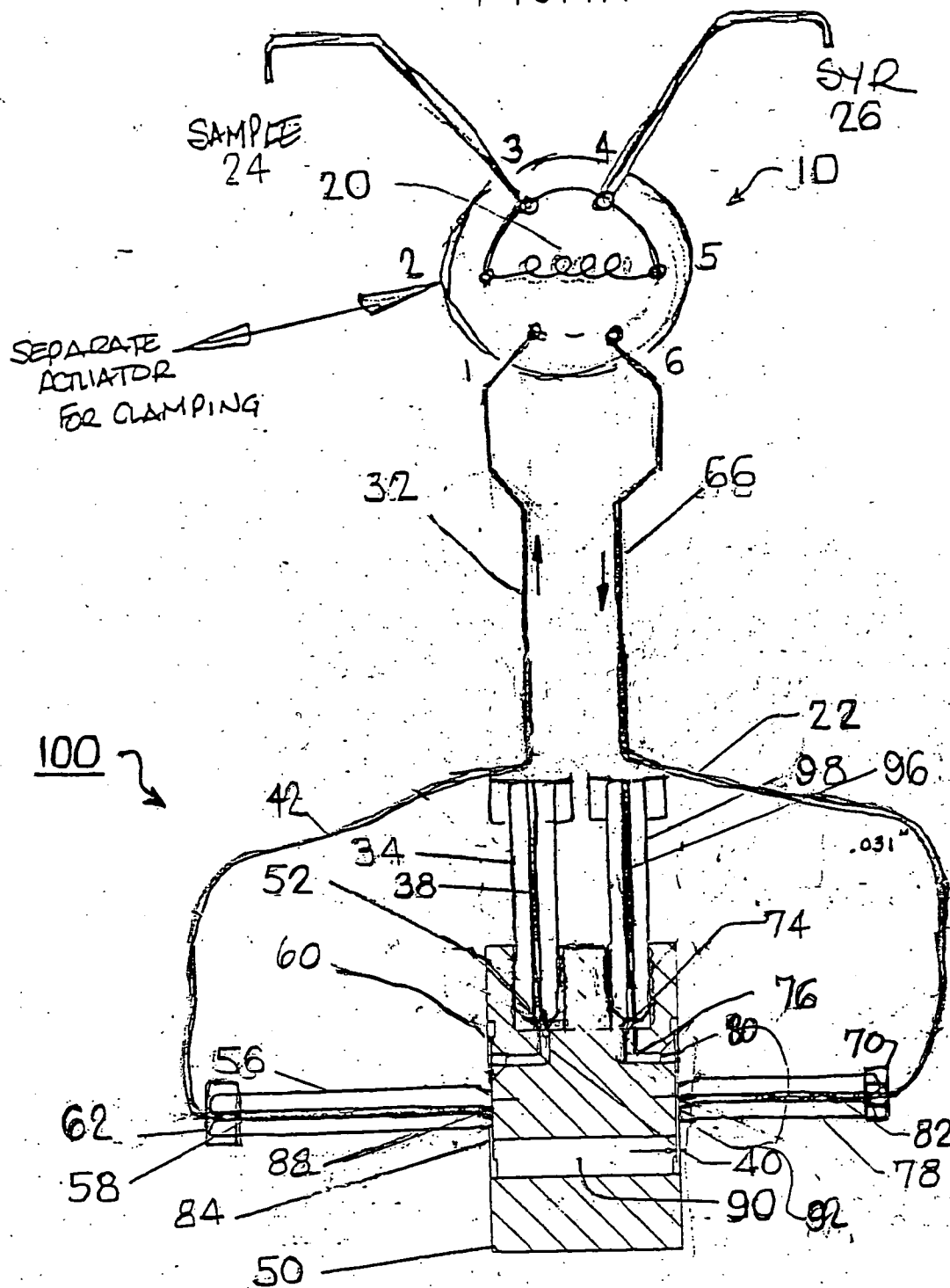


FIG. 18

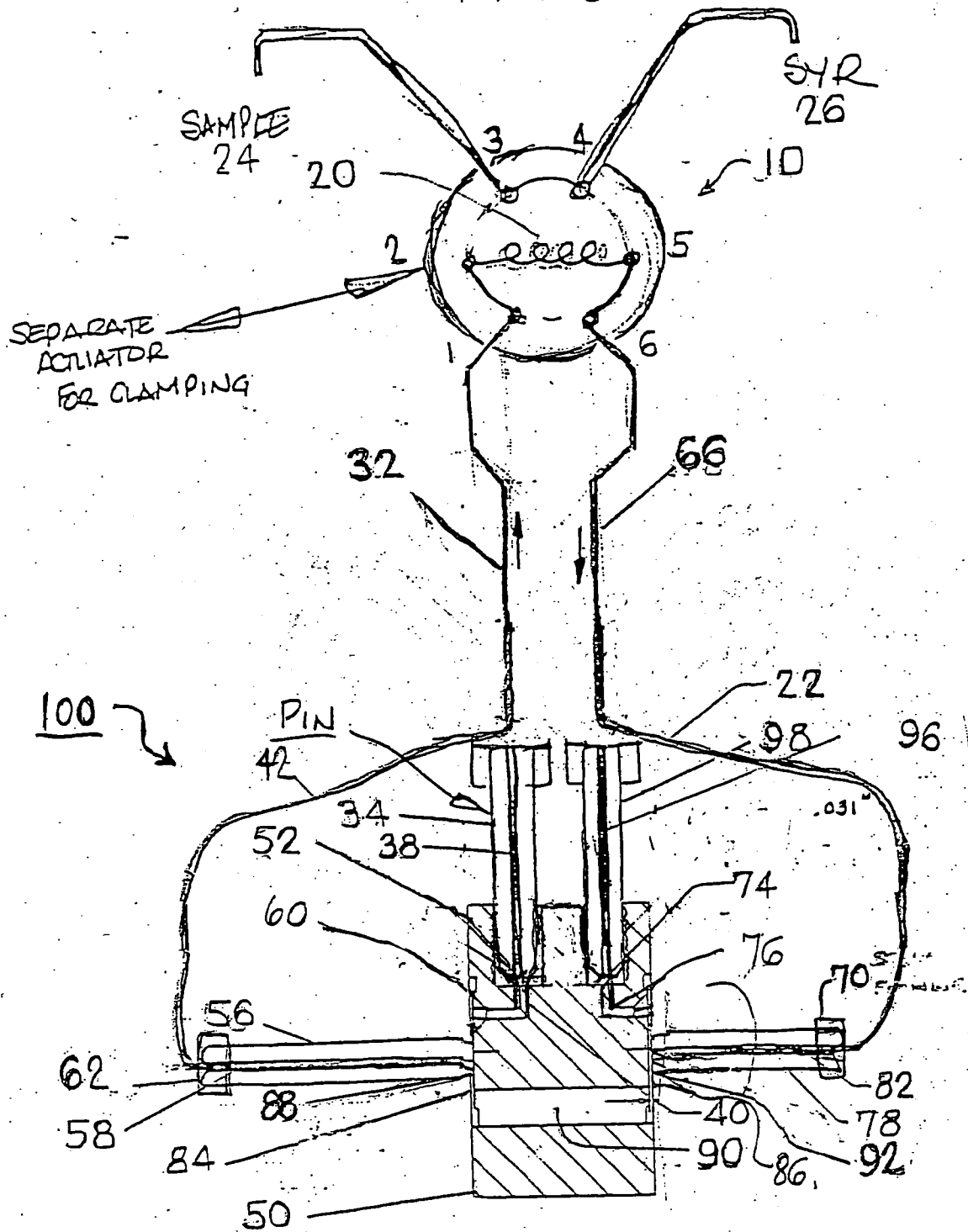
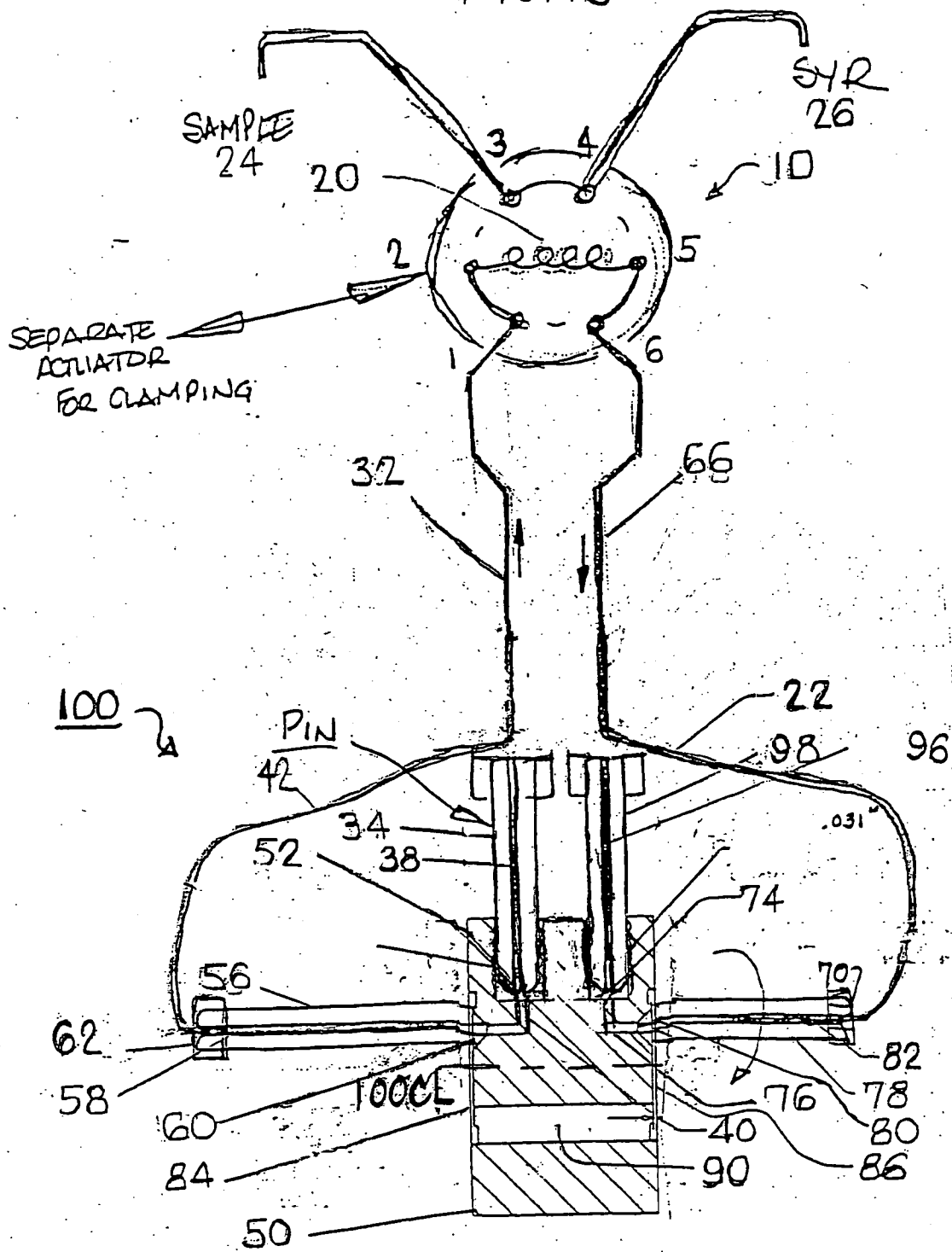


FIG. 1C



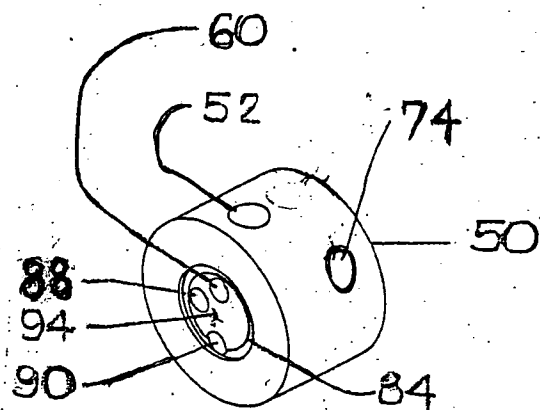
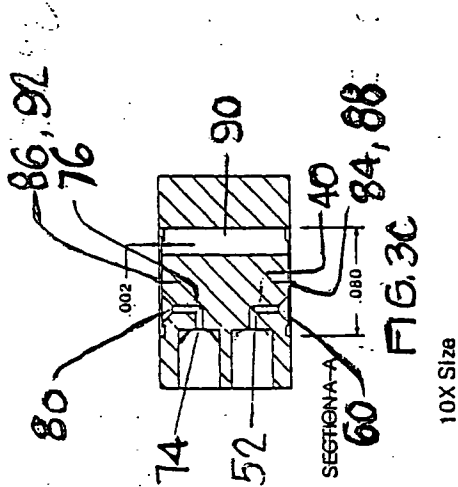
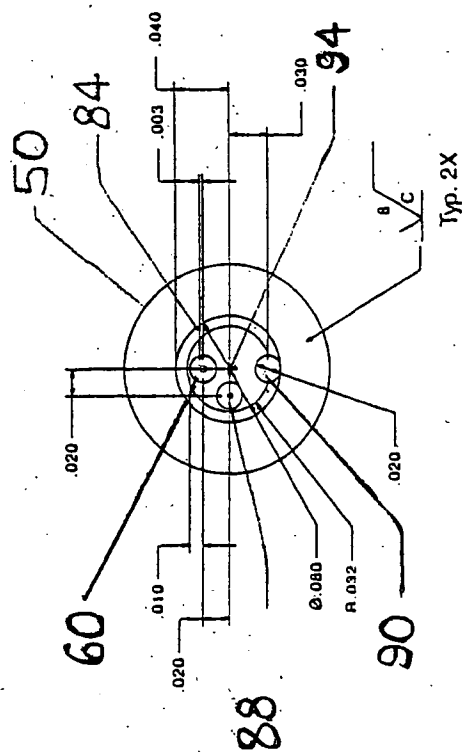


FIG. 2



F. G. AB



F16.3A

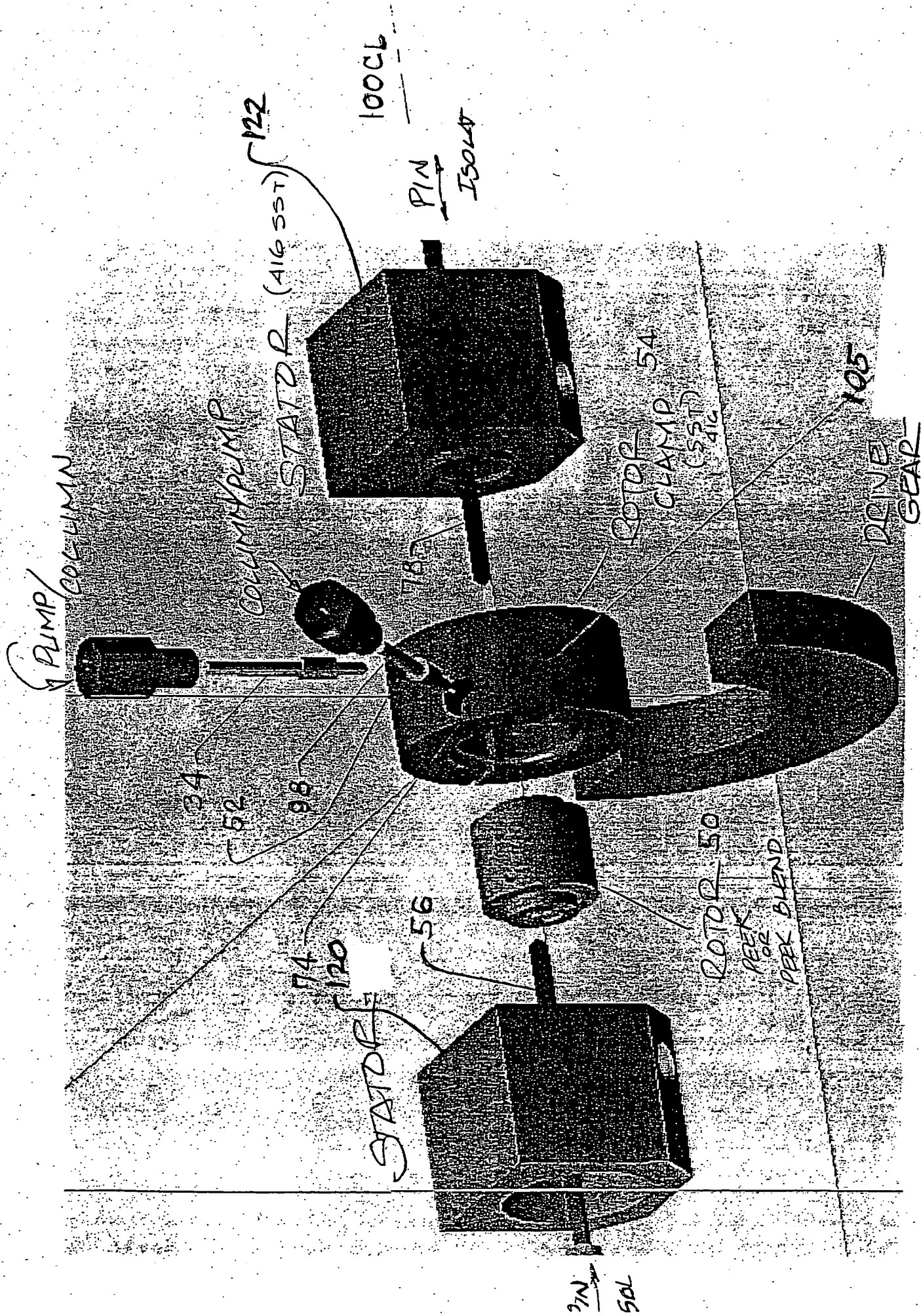
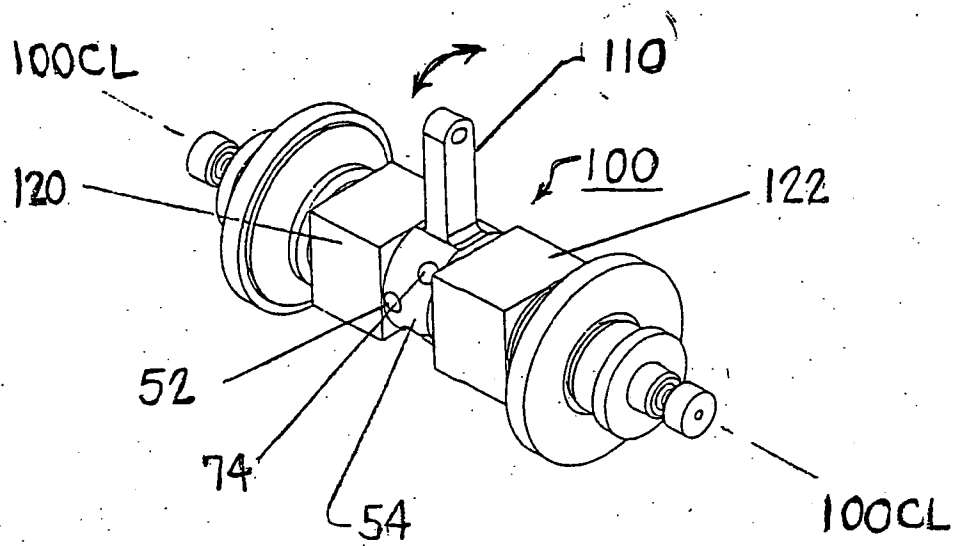


FIG 4

FIG. 5



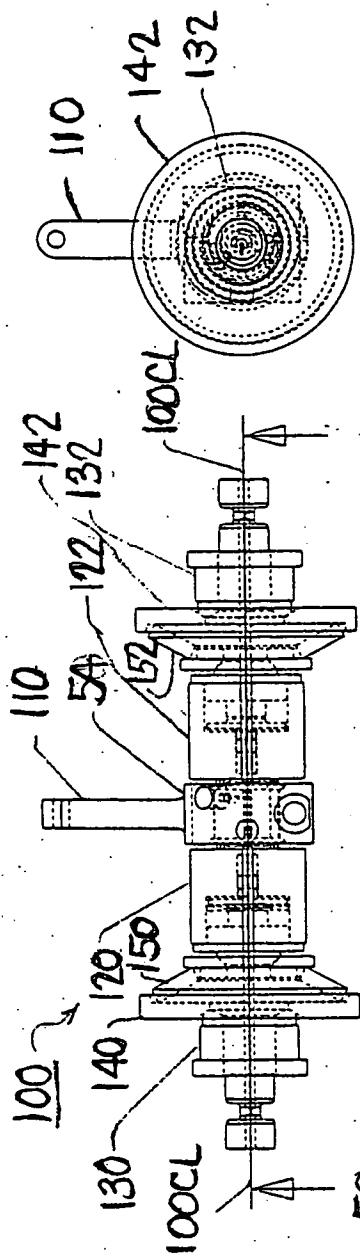


FIG. 5A

5C

Scale : 2X Size

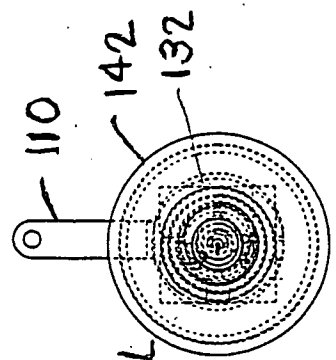
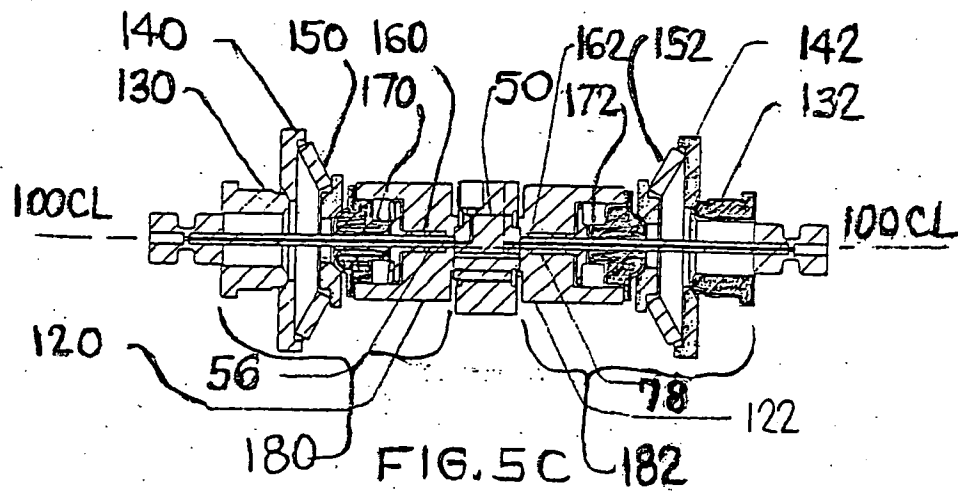


FIG. 5B

5C



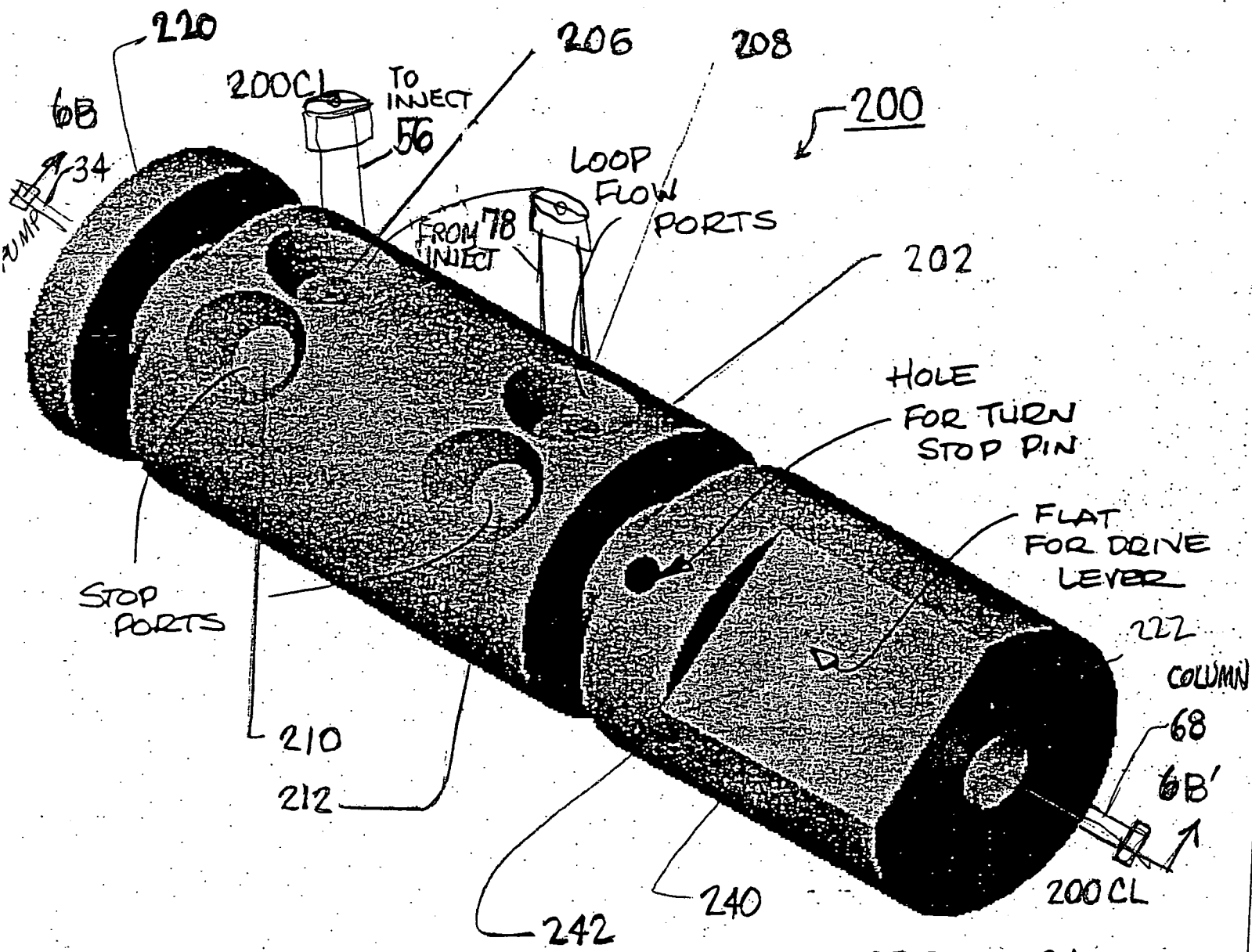
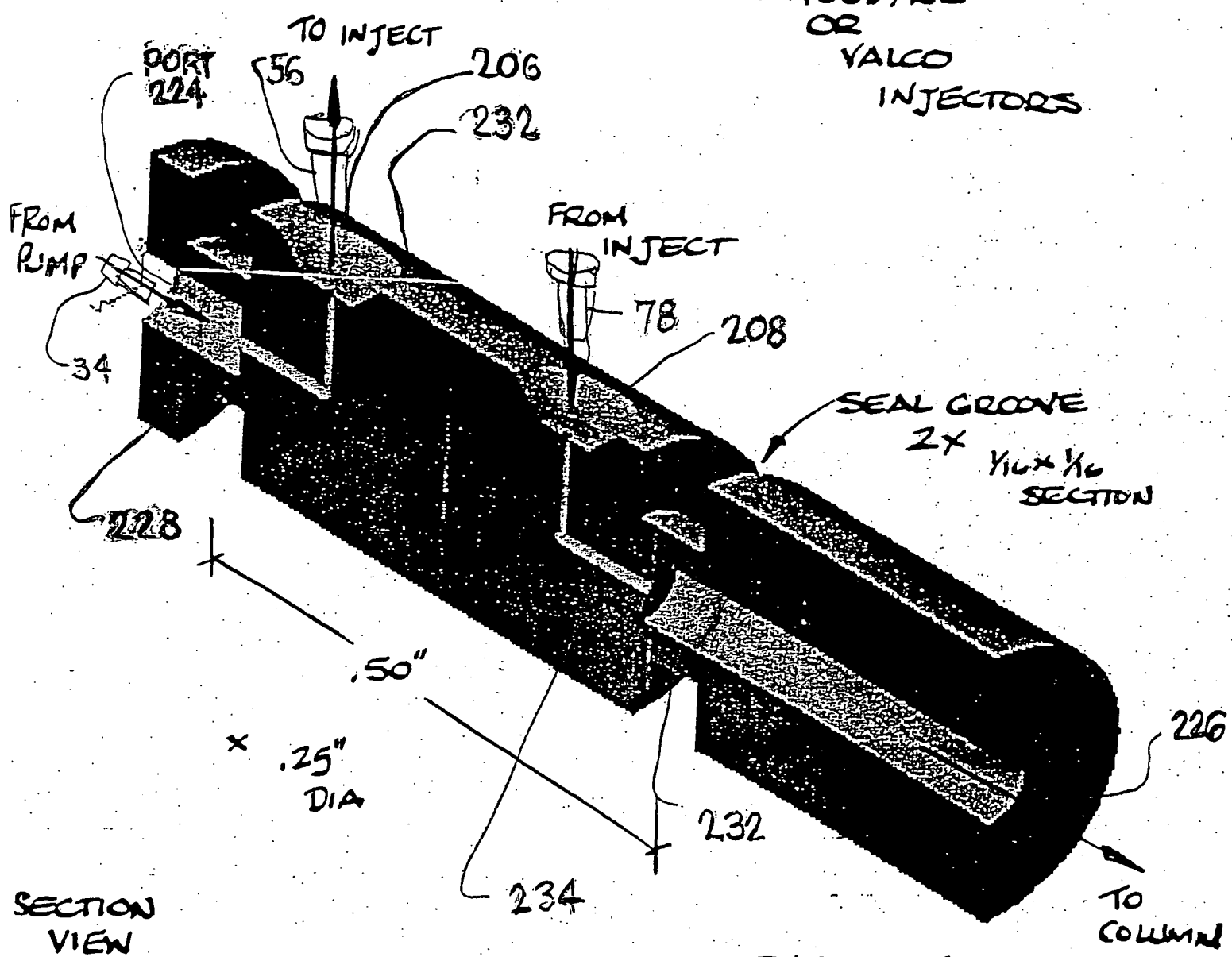


FIG. 6A

CONCEPT - VHP LOOP VALVE ROTOR

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— COULD USE
EITHER
RHEODYNE
OR
VALCO
INJECTORS



SECTION
VIEW

FIG. 6B

CONCEPT - VHP LOAD VALVE
ROTOR

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FIG. 7

